Original scientific paper
Originalan naučni rad
UDK: 581.526.32(497.6RS)
DOI: 10.7251/AGREN1502215K

University of Banjaluka, Faculty of Agriculture
Agro-knowledge Journal

Association *Scirpo-Phragmitetum communis* W. Koch 1926 in the Ramsarian Area of Bardača

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Abstract

Stands of the association of *Scirpo-Phragmitetum communis* W. Koch 1926 are developing as a secondary emersive vegetation that represents a transition from wetland to terrestrial vegetation. Edificatory type of association, *Phragmites communis* L. is in competition with *Typha latifilia* L., and based on the water depth and land characteristics one of those two types dominate by forming sub-associations *phragmitetosum* Schmalle 1939 and *typhaetosum* (*angustifoliae-latifoliae*) Soó 1973. Using Braun-Blanquet methodology on the basis of 10 phytocoenological clips brought to the conclusion of the domination of the *phragmitetosum* sub-association Schmalle 1939. This sub-association develops in a zone around water pools and the web of canals or makes islands in singular pools or covers entire pool surface during draught. The development of the stands of subassociation of *typhaetosum* (*angustifoliae-latifoliae*) Soó 1973 is conditioned with the higher level of water. Stands are floristically empty and the dinamics is hard to notice. Floristic structure of the association contains 34 herbal species: *Phragmites communis* Trin., *Typha latifolia* L. and *Amorpha fruticosa* L. The invasive species, *Amorpha fruticosa* L. enters the structure of seven stands with relatively small covering value and it either makes peripheral band and canal webs or mixes with *Phragmites communis, Salix* and *Populus*. Dominant life form of this association is cryptophyta (47,06%). In the areal spectrum, widely spread flora elements are dominating (82,35%). The values of ecologic indexes point to hydro-helophyta character of stands developing on the neutral or low-acid lands, mineral substances with medium security and adequate light and

temperature conditions. The significance of the research can be viewed from both negative and positive aspects of influence on the ecosystem in general.

Key words: biological spectrum, areal spectrum, *Scirpo-Phragmitetum communis*

Introduction

The Ramsarian area of Bardača is situated in the Lijevče Polje region, on the confluence of rivers Vrbas and Sava. Until 1904, it was a neglected pond and by 1932 it developed into full-system artificial fishpond. Hydro-technical works had great influence on the genesis of the habitat. They were performed in order to create conditions for intensive agricultural production and fish breeding, as well as the protection from floods. The area covers around 810 ha of water surfaces made of 11 pools used as 732 ha of cipridae fishponds. This very rich hydrological web is the basic precondition for the development of secondary aquatic and semi-aquatic vegetation. Aquatic flora and vegetation have multiple positive effect on water ecosystems: source of primary production of biomass, providing oxygen, bioaccumulation and biodetoxication, phyto-recovery capability, allelopathic effect, anti-thermal effect, anti-erosive and bioindicative role. Except positive effect, aquatic flora and vegetation have negative roles: slowing down the water flow, decrease of throughput capability of watercourse, aggravation of water supply and sail, accelerated eutrofisation of water surfaces and aquatic weeds (Janjić, 2000; Konstantinović and Meseldžija, 2001). In order to increase productivity of water in fishpond, it is of primary importance to create most adequate conditions for the development of primary production, which is itself a precondition for the development of secondary production of sources of natural fish food (Stojanović et al., 2007). Positive influence is tied to the nutrition of graham types of fish (*Hypophthalmichtys molitrix, Hypophthalmichthys nobilis, Ctenopharyngodon idella*) and the preservation of the fishpond embankments (Hristić and Bunjevac, 1996). Specific increase of Zn content in shoots of *Phragmites australis* (Cav.) Trin. ex Steud. at Sinjak locality indicate that specific conditions of the particular habitat have great influence on accumulation and distribution of Zn in this species. Increased Cu content in both *Phragmites australis* (Cav.) Trin. ex Steud. and *Typha latifolia* L. in May and June suggest that aditional release of Cu occured at Sinjak and

Matura localities (Maksimović et al., 2014). Researches of this area have so far been scarce and partial and therefore did not have character of ecosystem. The anthropogenic influence acts more intensively on the drastic decrease of diversity and degradation of habitat which is necessary to stop in order to preserve functional integrity of aquatic ecosystems, and that is possible only with integral approach by principles of sustainable development.

Material and Methods

For floristic phytocoenological research a standard Braun-Blanquet methodology is used on 10 phytocoenological stands. The collected herbal material is determinate according to publications Flora SR Srbije I-X (Josifović (ed.) 1970–1986) and Visugyi hidrobiologia (Felföldy, 1990). The floristic analysis of established taxons covers ecologic and phyto-geographic analysis. For the ecologic analysis, ecologic indexes of herbal species (Kojić et al, 1997) are used. Nomenclature in signifying herbal species is accorded to the publication Flora SR Srbije I-X (Josifović (ed.) 1970–1986). Life forms are showed according to Kojić's work (1997) and flora elements according to Gajić's work (1980).

Results and Discussion

Floristic structure of the association is made of 34 herbal species (Phytocoenological table 1). General covering of herbal cover is 80-100%. General number of herbal species which enter the structure of certain stands is from 4 to 12. Characteristic species of this association are: *Phragmites communis* Trin. (IV; 5125), *Typha latifolia* L. (III; 2200), *Typha angustifolia* L. (II; 925) i *Schoenoplectus lacuster* (L.) Palla (I; 100). In the floristic structure of stands of the association the most significant diagnostic element in almost all stands is *Phragmites communis* (Trin.) that makes clean and very thick stands (nudums) on certain locations. These species have sub-dominant role in stands of the association: *Mentha aquatica* L. (III; 375), *Glyceria maxima* (Hartm.) Hol. (III; 250) i *Rumex hydrolapathum* Huds. (II; 475). There is 13 characteristic herbal species for ordinances and classes with low degree of presence and very low covering values. As far other species are concerned, the most significant is the invasive *Amorpha fruticosa* L. (IV; 453). The characteristic group of this association is made of: *Phragmites communis* Trin., *Typha latifolia* L. and *Amorpha fruticosa*

L., i.e. only three species out of 34, which means their structure differs. In the vegetation of canal Novi Sad–Savino Selo Džigurski et al. (2010) state that species *Phragmites communis* Trin. provides a major physiognomic feature to all stands of the association *Scirpo-Phragmitetum communis* W. Koch 1926. The floristic structure is made up by 20 plant species whose numbers and cover values are low. *Butomus umbellatus* L., the characteristic species of the class *Phragmitetea*, is an exception. Its numbers and percentages of cover are quite high in several stands. *Amorpha fruticosa* L. is part of 7 stands with relatively small cover value and either makes peripheral band of pool and canal web or mixes with *Phragmites communis* Trin., *Salix* and *Populus* in the shape of oasis. It represents very aggressive, autochthonous, bushy specie which colonizes flooded habitat (Tucović and Isajev, 2000). Its notable characteristic is chromosomal, anatomic, morphologic and physiologic polymorphism. When in flooded habitats, depending on ecologic factors, it transforms into aggressive weed and it subspontaneously penetrates the structure of 12 stands. Jovanović et al. (2000) state that the habitats in which are develope stand of association *Scirpo-Phragmitetum communis* W. Koch in 1926 characterized by high levels of ground water, which is a longer part of the year reserves above ground and performs water-logging area and the community floristic are very poor, and the most common species are: *Phragmites communis* Trin.*, Filipendula ulmaria* (L.) Maxim.*, Lysimachia vulgaris* L.*, Scirpus sylvaticus* L.*, Poa palustris* L. and *Epilobium hirsutum* L. Stands of the association of *Scirpo-Phragmitetum communis* W. Koch 1926 *medioeuropaeum* Tx. 1941 p.p. emend. Soó 1971 grow in fragments on the pasture and the banks of drainage canals (Knežević et al., 2014). Tanase and Stefan (2010) allegations that characteristic species of association *Scirpo-Phragmitetum communis* W. Koch 1926 are *Schoenoplectus lacustrer* (L.) Palla and *Phragmites australis* (Cav.) Trin. ex Steud. which occupying the small area of ponds or lakes with water.

Phytocoenological table 1.

Fitocenološka tabela 1.

Association *Scirpo-Phragmitetum communis* W. Koch 1926 *Asocijacija Scirpo-Phragmitetum communis* W. Koch 1926																			
Locality / *Lokalitet*	Bardača										The level of presence *Nivo prisutnosti*	Cover value *Vrijednost pokrovnosti*	Ecological i fitogeografical characteristics						
Altitude height (m)/ *Nadmorska visina*	90																		
Size of stands (m²)/ *Veličina sastojine*	100	100	100	100	100	100	100	100	100	100			Ecological index *Ekološki indeks*					Life forms/ *Životne forme*	Floral elements *Florni elementi*
General coverage (%)/ *Opšta pokrovnost*	100	100	100	100	100	80	100	100	100	100									
Total number of species in the stands *Ukupan broj vrsta u sastojini*	8	8	7	8	7	9	4	12	9	7									
Number of stands* *Broj sastojina**	1	2	3	4	5	6	7	8	9	10									
Subassociation *Podasocijacija*	*phragmitetosum* Schmalle 1939							*typhaetosum* (*angustifoliae–latifoliae*) Soó 1973					F	R	N	L	T		
Characteristic species of the association *Scirpo- Phragmitetum communis* W. Koch 1926 *Vrste karakteristične za asocijaciju Scirpo- Phragmitetum communis* W. Koch 1926																			
Phragmites communis Trin.	9,5	9,4	8,4	9,5	8,3	7,3	9,5	.	.	.	IV	5125	5	3	3	3	3	g	Cosm.
Typha latifolia L.	.	.	3,1	.	5,2	5,2	.	9,5	3,1	9,5	III	2200	5	3	3	4	4	g	Cosm.
Typha angustifolia L.	3,1	.	.	3,1	.	.	.	.	9,4	.	II	925	5	3	3	4	4	g	Circ.
Schoenoplectus lacuster (L.) Palla	.	.	3,1	.	.	.	.	.	3,1	.	I	100	5	3	3	4	4	g	Cosm.

Phytocoenological table 1. – continued

Fitocenološka tabela 1. – nastavak

Characteristic species bond *Phragmition communis* W. Koch 1926, order *Phragmitetalia communis* (W. Koch 1926) R. Tüxen et Preising 1942 and class *Phragmitetea communis* R. Tüxen et Preising 1942																			
Mentha aquatica L.	3,1	3,1	.	5,2	.	.	3,1	.	.	3,1	III	375	5	3	3	3	3	g	Euroasian
Glyceria maxima (Hartm.) Hol.	3,1	3,1	3,1	.	.	.		3,1	.	3,1	III	250	5	4	5	4	3	g	Circ.
Rumex hydrolapathum Huds.	.	.	.	.	.	.	3,1	7,3	3,1	.	II	475	5	3	4	3	3	h	Subce.
Solanum dulcamara L.	.	5,2	.	.	.	.	.		.	.	I	175	4	3	4	3	3	d c	Subeuroa sian
Iris pseudacorus L.	.	.	.	.	.	.	.	3,1	.	3,1	I	100	5	3	4	3	3	g	Subeuroa sian
Calystegia sepium (L.) R.Br.	.	.	.	.	.	3,1	.	3,1	.	.	I	100	4	4	4	3	3	g	Euroasian
Roripa silvestris (L.) Bess.	.	.	2,1	.	.	3,1	.	.	.	.	I	51	4	4	3	4	4	h	Subeuroa sian
Eupatorium cannabinum L.	.	.	.	.	.	2,1	.	3,1	.	.	I	51	4	4	3	3	3	h	Subce.
Polygonum hydropiper L.	.	.	.	.	.	3,1	.	.	.	.	I	50	4	2	3	3	3	th	Subcirc.
Sagittaria sagittifolia L.	.	.	.	3,1	.	.	.	.	.	.	I	50	6	3	3	3	3	g	Euroasian
Acorus calamus L.	.	.	.	.	.	.	.	3,2	.	.	I	50	5	3	3	4	3	g	Adv.
Lythrum salicaria L.	2,1	.	2,1	.	.	.	.	.	.	.	I	2	4	3	3	3	3	h	Pont.-ca.-subm.
Sparganium simplex Huds.	.	.	.	2,1	2,1	.	.	.	.	.	I	2	5	3	4	4	4	g	Circ.
Lycopus europaeus L.	.	.	.	.	2,1	.	.	.	.	.	I	1	5	3	3	3	3	g	Subeuroa sian
Alisma plantago-aquatica L.	.	.	.	.	2,1	.	.	.	.	.	I	1	6	3	3	4	3	g	Cosm.
Butomus umbellatus L.	.	.	.	2,1	.	.	.	.	.	.	I	1	5	3	4	3	3	g	Euroasian

Phytocoenological table 1. – continued

Fitocenološka tabela 1. – nastavak

Other species *Ostale vrste*																			
Amorpha fruticosa L.	5,2	3,1	.	5,2	3,2	2,1	2,1	.	.	2,1	IV	453	4	3	3	3	4	np	Adv.
Salix fragilis L.	3,1	.	.	.	5,2	5,2	.	.	.	.	II	400	4	3	3	3	3	p	Subce.
Salix alba L.	3,1	.	2,1	3,1	.	.	.	.	.	.	II	101	4	4	4	3	3	p	Subevroasian
Marsilea quadrifolia L.	.	.	.	.	.		.	3,1	2,1	3,1	II	101	6	3	3	4	4	g	Circ.
Populus alba L.	.	.	.	.	.	3,1	.	3,2	.	.	I	100	3	4	3	4	5	p	Subsourth.sib.
Lemna minor L.	.	.	.	.	.	.	.	2,1	3,1	.	I	51	6	3	3	4	3	a	Cosm.
Caltha palustris L.	.	3,2	.	.	.	.	.	.	.	.	I	50	5	3	3	3	3	h	Circ.
Ceratophyllum demersum L.	.	.	.	.	.	.	.	.	3,1	.	I	50	7	4	5	3	4	a	Cosm.
Sambucus nigra L.	.	3,1	.	.	.	.	.	.	.	.	I	50	3	3	4	3	4	np	Subce.
Convolvulus arvensis L.	.	3,1	.	.	.	.	.	.	.	.	I	50	2	4	3	4	3	g	Cosm.
Nymphoides peltata (Gmel.) Ktze.	.	.	.	.	.	.	.	.	2,1	2,1	I	2	5	3	4	4	5	a	Euroasian
Lemna trisulca L.	.	.	.	.	.	.	.	2,1	.	.	I	1	6	3	3	4	3	a	Cosm.
Spirodela polyrrhiza (L.) Schl.	.	.	.	.	.	.	.	.	2,1	.	I	1	6	3	3	4	4	a	Cosm.
Hydrocharis morsus-ranae L.	.	.	.	.	.	.	.	2,1	.	.	I	1	6	3	3	3	4	a	Euroasian
Total / *Ukupno*												11495							

*Number of stands: 1 - Dugo polje I, 2 - Dugopoljski lug, 3 - Sinjak, 4 - Necik, 5 - Rakitovac, 6 - Mali Dajkovac, 7 - Ljetni bazen, 8 - Dugo polje II, 9 - Prevlaka, 10 – Ljetni bazen

On the basis of floristic and ecologic characteristics in the frame of stands of the association *Scirpo–Phragmitetum communis* W. Koch 1926, two sub-associations have been found: *phragmitetosum* Schmalle, 1939 and *typhaetosum* (*angustifoliae–latifoliae*) Soó 1973. The sub-association *phragmitetosum* develops in the habitats with shallower water, on the peripheral bands of pools and canal webs. Considering that the edificatory *Phragmites communis* Trin. has wide atomicity comparing to the wetness of habitat of this stand, these stands are in contact with floating and meadow vegetation. The stands of this sub-association are represented with phytocoenological stands 1-7. The sub-association is characterized by significant floristic wealth (25 herbal species) and great quantitative involvement of *Phragmites communis* Trin. These species have sub-dominant role: *Amorpha fruticosa* L. *Typha latifolia* L., *Typha angustifolia* L., *Mentha aquatica* L. and *Glyceria maxima* Hartm. The stands of the *typhaetosum* (*angustifoliae–latifoliae*) sub-association develop in shallow water near the pool bank. Their surfaces are significantly smaller (phytocoenological stands 8-10). The dominant life form (Table 1) of *Scirpo–Phragmitetum communis* W. Koch 1926 is cryptophyta, out of which 47,06% (16 herbal species) are geophyta. Aquatic helo-hydrophyta, with 17,56% (6 herbal species) indicate wet habitat. Hemi-cryptophyta with 14,71% (5 herbal species) show that association makes transition to the wetland vegetation. It is important to note the presence of phanaerophyta (8,82%) and nano-phanaerophyta (5,88%), mostly in the sub-association of *phragmitetosum* Schmalle, 1939. Musayev et al. (2015) in Azerbaijan's water-marsh ecosystem said that biological spectrum made: cryptophytes (43,6%), terophytes (27,7%), hemicryptophytes (20,1%), phanerophytes (7,8%) and chamaephytes (0,6%).

In the areal spectrum of widely spread flora elements (Table 2) dominantly prevail (82,35%): cosmopolite (26,47), Euro-Asian (17,65%), circumpolar (14,71%), sub-Euro-Asian (11,76%), adventives (5,88%), sub-circumpolar (2,94%) and sub-south-Siberian (2,94%). The participation of narrowly spread flora elements is significantly lesser – 17,65%, and it is made of sub-central-European (14,71%) and pontic-central-Asian-sub-Mediterranean (2,94%).

The average values of ecological indexes of the association *Scirpo–Phragmitetum communis* W. Koch, 1926 are given in Table 3.

Tab. 1. Biological spectrum of the association *Scirpo–Phragmitetum communis* W. Koch 1926

Biološki spektar asocijacije Scirpo–Phragmitetum communis W. Koch 1926

Life forms *Životne forme*	Number of species *Broj vrsta*	%
Geophytes	16	47,06
Aqatic helo–hidrophytes	6	17,65
Hemicriptophytes	5	14,71
Phanerophytes	3	8,82
Nanophanerophytes	2	5,88
Woody chamaephytic	1	2,94
Terofit–chamaephytic	1	2,94
Total/*Ukupno*	34	100,00

Tab. 2. Areal spectrum of the association *Scirpo–Phragmitetum communis* W. Koch 1926

Areal spektar asocijacije Scirpo–Phragmitetum communis W. Koch 1926

Floral elements *Florni elementi*	Number of species *Broj vrsta*	%
Cosm.	9	26,47
Euroasian	6	17,56
Circ.	5	14,71
Subce.	5	14,71
Subeuroasian	4	11,76
Adv.	2	5,88
Subcirc.	1	2,94
Subsourth.sib.	1	2,94
Pont.ca.subm.	1	2,94
Total/*Ukupno*	34	100,00

Table 3. The average values of ecological indexes of the association *Scirpo–Phragmitetum communis* W. Koch, 1926

Srednje vrijednosti ekoloških indeksa asocijacije Scirpo–Phragmitetum communis W. Koch, 1926

Ecological indexes *Ekološki indeksi*	The average values of ecological indexes of the releves *Srednje vrijednosti ekoloških indeksa po sastojinama*										Average values *Srednje vrijednosti*
	1	2	3	4	5	6	7	8	9	10	
F	4,58	4,28	4,74	4,84	4,78	4,27	4,88	4,93	5,43	5,04	4,78
R	3,19	3,19	3,30	3,09	3,00	3,24	3,00	3,28	3,10	3,12	3,15
N	3,29	3,44	3,35	3,22	3,07	3,09	3,18	3,44	3,37	3,44	3,29
L	3,19	3,19	3,48	3,16	3,33	3,33	3,00	3,58	3,80	3,68	3,37
T	3,26	3,19	3,35	3,31	3,37	3,48	3,12	3,47	3,87	3,72	3,41

The average value of ecological index for land wetness (F) with the interval of 4,27-5,43 (mid.v. 4,78) is in accordance with the ecology of the analyzed emersive association and it points out hydro-helophyta character of stands. The stands 8, 9 and 10 that belong the *typhaetosum* (*angustifoliae-latifoliae*) sub-association, according to the values of ecological index for land wetness, have more wetlands in habitat than the *phragmitetosum* sub-association, which is also in accordance with the ecology of the association. The average value of ecological index for chemical reaction of the surface (R) with the interval of 3,00-3,30 (mid.v. 3,15) point out that the stands develop on neutral and low-acid ground. The span of values of ecological index for nitrogen containment in the ground (N) is 3,07-3,44 (mid.v. 3,29) and it indicates that habitats have average provision of mineral substances. The value of ecological index for light (L) of 3,00-3,80 (mid.v. 3,37) points out the presence of semi-sciophyta (3) and transition group between semi-sciophyta and helophyta (4). The average value of ecological index for temperature (T) is 3,12-3,87 (mid.v. 3,41) and points out the favorable warmth conditions in the habitat.

Conclusion

Floristic structure of the association *Scirpo–Phragmitetum communis* W. Koch, 1926 contains 34 herbal species.

Characteristic species of the association are: *Phragmites communis* Trin., *Typha latifolia* L., *Typha angustifolia* L. and *Schoenoplectus lacuster* (L.) Palla.

The most significant diagnostic element in the floristic structure of stands is the *Phragmites communis* Trin specie that makes clean and very thick stands (nudums) on certain locations.

In the frame of stands of the association *Scirpo–Phragmitetumcommunis*, two sub-associations have been found: *phragmitetosum* Schmalle, 1939 and *typhaetosum* (*angustifoliae-latifoliae*) Soó, 1973. The stands of the *phragmitetosum* sub-association develop in habitats with shallower water, on the peripheral bands of pools and canal webs, and they are floristically very rich. The floristically poorer sub-association, *typhaetosum* (*angustifoliae-latifoliae*), cover significantly less surface and develop in shallow water by the pool bank.

The association has geophyta-hemicryptophyta character with the dominance of widely spread flora elements.

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Received: March 20, 2015
Accepted: May 20, 2015

Asocijacija *Scirpo-Phragmitetum comunis* W. Koch 1926 u Ramsarskom području Bardača

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Sažetak

Sastojine asocijacije *Scirpo-Phragmitetum communis* W. Koch 1926 se razvijaju kao sekundarna emerzna vegetacija koja u ekološkom pogledu predstavlja prelaz od vodene ka suvozemnoj vegetaciji. Edifikatorska vrsta asocijacije, *Phragmites communis* L. je u konkurenciji sa *Typha latifilia* L., te u zavisnosti od dubine vode i osobina zemljišta dominira jedna ili druga vrsta obrazujući subasocijacije *phragmitetosum* Schmalle1939 ili *typhaetosum* (*angustifoliae-latifoliae*) Soó 1973. Standardnom Braun-Blanquet (1964) metodom na osnovu 10 fitocenoloških snimaka konstatovana je dominacija subasocijacije *phragmitetosum* Schmalle1939 koja se razvija u vidu pojasa oko vodenih bazena i kanalske mreže ili gradi ostrva u pojedinim bazenima, te u sušnom periodu koji rezultira totalno smanjenje nivoa vode prekriva gotovo cijele površine bazena. Razvoj

sastojina subasocijacije *typhaetosum* (*angustifoliae-latifoliae*) Soó 1973 uslovljen je višim nivoom vode. Sastojine asocijacije su floristički 'prazne', a dinamika je slabo uočljiva. Florističku strukturu asocijacije čine 34 biljne vrste. Karakteristični skup asocijacije čine: *Phragmites communis* Trin., *Typha latifolia* L. i *Amorpha fruticosa* L. Poseban značaj ima invazivna vrsta *Amorpha fruticosa* L. koja ulazi u sastav 7 sastojina sa relativno malom pokrovnom vrijednošću i čini rubni pojas bazena i kanalske mreže, ili je u obliku oaza izmiješana sa *Phragmites communis* L. i vrstama rodova *Salix* i *Populus*. Dominantna životna forma asocijacije su kriptofite (47,06%). U areal spektru dominiraju florni elemenati širokog rasprostranjenja (82,35%). Vrijednosti ekoloških indeksa ukazuju na hidro-helofitski karakter sastojina koje se razvijaju na neutralnom do slabo kiselom zemljištu, srednje obezbjeđenom mineralnim materijama i povoljnim svjetlosnim i temperaturnim uslovima. Značaj istraživanja se može sagledati sa aspekata negativnih i pozitivnih uticaja na ekosistem uopšte.

Ključne riječi: biološki spektar, areal spektar, *Scirpo-Phragmitetum communis*

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Primljeno: 20. mart 2015.
Odobreno: 20. maj 2015.